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EFFECT OF SUGAR MAPLE ROOT EXUDATE ON SEEDLINGS OF NORTHERN CONIFER SPECIES

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ABSTRACT.--It has previously been shown that a root exudate of sugar maple reduces the growth of yellow birch. A laboratory test indicated that the growth of northern conifers is also reduced in sugar maple root exudate. Allelopathy may play an important role in survival of species on sites where sugar maple is abundant.

OXFORD: 181.41:161.35:181.36:176.1(*Acer saccharum*). KEY WORDS: allelopathy, *Acer saccharum* Marsh., *Betula alleghaniensis* Britton.

It has been previously shown that sugar maple seedlings are capable of inhibiting growth of yellow birch seedlings (Tubbs 1973) by means other than normal competition. When sugar maple leaves are mature, exudates from the growing roots reduce the growth of the roots of yellow birch. This is followed in turn by a reduction in the growth of birch stems. In nature, this limits the survival of yellow birch in northern hardwood stands.

Sugar maple ultimately invades many plant communities, both natural and planted. The purpose of the present experiment was to determine if some northern conifers, especially those with easily germinated seeds, are affected as yellow birch is.

METHODS

Dormant sugar maple seedlings were lifted from stands at the Upper Peninsula Experimental Forest. Dormancy was broken by cold treatment and the seedlings were potted and grown in a greenhouse until the first leaves were fully expanded. Actively growing roots were then allowed to soak in distilled water for 48 hours in the dark at 41°F (5°C).

Four-tenths of a milliliter of the leachate was deposited on small steel planchets and evaporated to dryness.

Uniformly sized newly germinated seedlings[1] of black spruce (*Picea mariana* (Mill.) B.S.P.), tamarack (*Larix laricina* (DuRoi) K. Koch), jack pine (*Pinus banksiana* Lamb.), white spruce (*Picea glauca* (Moench) Voss), northern white-cedar (*Thuja occidentalis* L.), and yellow birch (*Betula alleghaniensis* Britton) were measured and placed on the planchets. Three milliliters of distilled water were added to each planchet (concentration of dry matter about 4×10^{-4} g/ml). The planchets were covered with plastic wrap and placed in covered glass dishes in the dark. Each dish contained all the species tested plus controls containing a seedling of each species to which only distilled water had been added. Each species was replicated eight times and there were four controls for each species.

The seedlings were allowed to grow 24 hours and were then remeasured. Comparisons

[1]*Thanks are due to Wesley Lehmann of the Michigan Department of Natural Resources for the seed used in this experiment.*

between controls and seedlings treated with maple root exudate were tested statistically by a "t" test.

RESULTS

All of the species were repressed when growing in the maple root exudate. Northern white-cedar growth was highly variable both in water and exudate so that the differences in growth was not statistically significant. Tamarack was the most sensitive to the exudate; yellow birch and black spruce were least sensitive (table 1).

Table 1.--*Growth of newly germinated seedlings in sugar maple root exudate compared to growth in distilled water*

Species	Treatment		Growth of treated seedlings as a percent of control
	Sugar maple exudate	Distilled water	
	mm	*mm*	*Percent*
Tamarack	0.7	3.3	21 *
White spruce	.4	1.0	40 *
Jack pine	.6	1.3	46 *
Black spruce	1.7	3.2	53 *
Northern white-cedar	.9	1.8	50 NS
Yellow birch	.9	1.4	64 *

* Significantly different from control at 5 percent level or better.
NS Nonsignificant.

DISCUSSION

The inhibitory material in sugar maple exudate may be as important in determining what tree species will dominate after a disturbance in northern hardwood stands as condition of seedbed, seed production, and advance reproduction.

Most of the species in this test can grow very well on typical well drained sandy loam sugar maple sites, even though in nature they are usually confined to either excessively well drained soils (jack pine) or poorly drained soils (tamarack, black spruce, white spruce, northern white-cedar).

For them to do well, however, sugar maple seedlings and sprouts must be absent. For example, an unweeded red pine planting at the Upper Peninsula Experimental Forest died out while the weeded portion survived well and grew at a rate of over 2 cords per acre for 46 years.[2] Observations of small test plantings of jack pine, spruce, and tamarack on cleared sugar maple sites indicate that these species also grow well if growth is not impeded by competing sugar maple. Yellow birch seedling survival and growth is good where sugar maple has been eradicated but poor where sugar maple has not been eliminated from the stand (Tubbs and Metzger 1969).

Except for cedar, the species, tested here are thought to be relatively intolerant of shade, which helps explain why they do not commonly invade existing stands of tolerant sugar maple. But even when light conditions are good for intolerant species, such as after clearcutting, there are fewer individuals of these species in the new stand than there are of the predominating sugar maple (Metzger and Tubbs 1971).

The reason that sugar maple is such a strong competitor in these cases seems at least partly due to its growth-inhibiting root exudate. Further field tests are needed with northern conifers to determine how important this inhibiting effect is in natural stands.

[2] *Unpublished data on file at the Northern Hardwoods Laboratory, Marquette, Michigan.*

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